R&D 100 Awards Sponsorship

The Industrial Business Development (IBD) Division serves as the link for technology transfer and Laboratory collaborations with private industry, universities, government agencies, and other national laboratories. IBD matches Laboratory scientific and technical talent, expertise, and facilities with research and development endeavors in external sectors for the advancement of national security, technological innovation, and economic competitiveness.

As part of our commitment to the transfer of technology beyond the Laboratory, IBD coordinates Laboratory participation in the annual R&D 100 Awards competition. In collaboration with technical staff and a dedicated, professional publications team from the Information Management Division, IBD submits the Laboratory's most innovative technologies to the R&D 100 review panel.

Contact information:
For information about R&D 100 participation, contact:

Cindy Boone
(505) 667-1229
boone@lanl.gov

For information about licensable technologies, contact:

John Mott, Ph.D.
(505) 665-0883
jmott@lanl.gov

For information about IBD, visit us on the Web at: http://www.lanl.gov/partnerships

R&D 100 Awards Recognition Ceremony

Thursday, May 30, 2002
Bradbury Science Museum
Los Alamos, New Mexico

1999
- Acoustic Stirling Heat Engine
- Atmospheric Pressure Plasma Jet
- CHEMIN: A Miniaturized X-Ray Diffraction and X-Ray Fluorescence Instrument
- PREDICT—A New Approach to Process Development
- Real-Time, Puncture-Detecting, Self-Healing Materials
- REED-MD: A Computer Code for Predicting Dopant Density Profiles in Semiconductor Materials
- The Sulfur Resistant Oxymitter 4000™
- ANDE: Advanced Nondestructive Evaluation System
- Electroexploded Metal Nanoparticles

2000
- ANDE: Advanced Nondestructive Evaluation System
- Electroexploded Metal Nanoparticles

2001
- Free-Space Quantum Cryptography
- SCORR—Supercritical CO_2 Resist Remover
- Tandem-Configured Solid-State Optical Limiter

1994
- Ultrasensitive Ultrasonic Transducer
- Telemetric Heat Stress Monitor
- Optical Biopsy System
- Lattice Boltzmann Permeameter
- Directed Light Fabrication of Complex Metal Parts
- Bartas Iris Identification

1995
- The Indigo-830
- ARS Chemical Fill Detector
- Hydride-Dehydride Recycle Process
- HIPPI-SONET Gateway
- Microsensor for VOCs
- Polymer Filtration System

1996
- TRACER (Transportable Remote Analyzer for Characterization & Environmental Remediation)
- PLASMAX (Plasma Mechanical Cleaner for Silicon Wafers)

1997
- Falcon: Breakthrough Software for Simulating Oil Reservoirs
- Rapid Size Analysis of Individual DNA Fragments
- ASR Detect—Diagnostic Method for Analyzing Degrading Concrete
- Dry Wash
- Plasma Source Ion Implantation for Enhancing Materials Surfaces
- High Performance Storage

1998
- Cyrax™—Portable, 3-D Laser-Mapping and Imaging System
- Low-Smoke Pyrotechnics
- SOLVE—Creating 3-D Pictures of Protein Molecules from X-Ray Diffraction Spots
- Underground Radio

From the Director

The recognition Los Alamos National Laboratory receives through its participation in *R&D Magazine's* annual, international, R&D 100 Awards competition calls attention to the broad scope of achievements that the Laboratory contributes to technological innovation in this country and, indeed, the world. Our discoveries in science and the applications that result play an important role in shaping the future of our nation. When we transfer our inventions and technological advances from the Laboratory to the private sector for commercial development, we strengthen the nation's economic security by enhancing our industrial competitiveness.

I commend our researchers for the diligence and creativity they have applied to developing the technologies submitted to this year's competition. I am pleased with the diversity of applications, which range from data transmission and security enhancements to health and safety, manufacturing, and energy sustainability. It is important to remember that these potentially award-winning technical and scientific innovations have been born out of Los Alamos' goal to create science that truly serves society. I believe every submission represented here is a winner for the Laboratory, the University, and the American taxpayers.

John C. Browne

1989 • Fourier Transform Flow Cytometer
        (FTCS-1)
      • Noncontact Super conductor
        Screening
      • Conducting Latices

1990 • Coolahoop
      • Universal Process for Fingerprint
        Detection
      • Fast Agarose Gel Electrophoresis
        (FAGE)
      • Solid-State NO_2 Sensor
      • Upconversion Solid-State Laser
      • A Broadband (ABB) Mw Absorption
        Spectrometer for Liquid Media
      • MdS2/SC Composites (Molybdenum
        Disilicide/Silicon Carbide)

1991 • Semi-Insulator Detector
      • Optical High-Acidity Detector
      • Resonant Ultrasonic Inspection (RUI)
      • Single Molecule Detector

1992 • Thermal Neutron Multiplicity
        Counter
      • Plastic Laser Dye Rods
      • Cryogenic Diamond Turning
      • Portable Laser Spark Surface Mass
        Analyzer (PLASSMA)
      • Zeeman Refractive Index Detector
      • Animated Display of Inferred
        Tongue, Lip, and Jaw Movements
        During Speech

1993 • Selenium-Based Reagents for the
        Evaluation of Chiral Molecules
      • Phase-Sensitive Flow Cytometry
      • Ultrafast Infrared Spectometer
      • Mini Elastic Backscatter Lidar

Los Alamos National Laboratory
R&D 100 Award Winners
1978–2001

1978 • Diamond Machining of Optics
     • Electronic Identification System
     • Electronic Device for Treating
       Tumors—Hyper Thermic Cancer
       Treatment

1980 • Wee Pocket Radiation Detector
     • Portable Multichannel Analyzer

1981 • Radio Frequency Quadrapole Linac

1982 • WC Field Computer System

1983 • Transuranic Waste Assay System

1984 • Superconducting Magnetic Energy
       System

1985 • BHTP—A Unique Scintillation
       Compound

1986 • Aurora Laser Beam Alignment
       System

1988 • Optical Microrobot Single-Cell
       Manipulator/Analysis System
     • Nuclear Material Solution Assay
       System
     • 32-Stepper Motor Position Controller
     • Mobile Beryllium Monitor
     • HTMS Reference Electrode
     • Oriented, Highly Anisotropic
       Conducting Polymer
     • Photoinjector for RF Linac
       Accelerators
     • Lattice Gas Algorithm

The R&D 100 Awards

For the past 24 years, Los Alamos National Laboratory has submitted descriptions of its most innovative technologies to *R&D Magazine's* annual R&D 100 Awards competition. This competition is designed to honor significant commercial promise in products, materials, or processes developed by the international research and development community. Technologies are nominated in open competition and judged by technical experts selected by the Illinois-based *R&D Magazine*. The magazine uses technical criteria to select the 100 most significant, unique, or promising entries from the nominations received. According to the selection panel, "The sole criterion for making the grade is demonstrable 'technological significance' compared with competing products and technologies. Issues such as smaller size, faster speed, greater efficiency, and higher environmental consciousness have continued to gain importance in successful award submissions."

Los Alamos has been competing successfully for more than two decades with many of its winning technologies developed in collaboration with private-sector companies and other scientific institutions. The Laboratory won three awards in 2001 and has received more than 75 awards since it began competing in 1978.

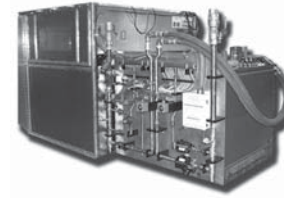## AMS/IB—Tool for Protecting Data and Verifying Container Contents

Duncan MacArthur
William S. Johnson
Robert P. Landry
Diana C. Langner
Douglas R. Mayo
Richard Morgado
Nancy J. Nicholas
Lawrence L. Sprouse
Rena Whiteson
Los Alamos National
Laboratory

James K. Wolford
Thomas B. Gosnell
S. John Luke
Gregory K. White
Lawrence Livermore
National Laboratory

The Attribute Measurement System with Information Barrier (AMS/IB) is a modular inspection technology for verifying the contents of sealed containers without revealing any sensitive or proprietary information about those contents. It was developed as an accurate means of monitoring compliance with nuclear disarmament treaties. The system allows inspectors to verify that sealed containers hold nuclear material from dismantled weapon components without compromising sensitive information about the components' design. It uses simple hardware and software shielded against electronic surveillance or tampering to gather and analyze sensitive information but transmit only nonsensitive pass/fail results. The AMS/IB technology has been accepted as the International Atomic Energy Agency's preferred approach for future arms control verification.

Applications:
- Monitoring international compliance with treaties for disarmament and nuclear-materials control
- Protecting sensitive personal information obtained from security checks based on whole-body imaging technologies
- Conducting quality-control inspections on food and drug projects

Polyphase Converter-Modulator: A Compact High-Voltage, High-Power System

William A. Reass
James D. Doss
Robert F. Gribble
Dan L Borovina
Michael T. Lynch
Paul J. Tallerico
David M. Baca
David A. Miera
Jacqueline S. Gonzales
Chris C. Roybal
Marvin R. Roybal
Gabriel R. Roybal
Sean E. Apgar
Matthew Fresquez
Pete G. Trujillo
Diego C. Jaramillo
John J. Sullard

The Polyphase Converter-Modulator is a compact indoor power system that generates 140-kilovolt, 11-megawatt pulses with a 1.1-megawatt average power. Our system incorporates three interconnected innovations: (1) the use of low voltage for most of the work (the voltage is stepped up just before output and only when needed), (2) high-power, three-phase conversion (DC to AC to DC) at 20 kilohertz, and (3) the exploitation of electromagnetic circuit resonance for power conversion and voltage multiplication. Key components we further developed for our system are from technologies proven in the traction-motor industry (high-speed trains): boost-transformer cores of amorphous nanocrystalline material and high-energy-density, self-clearing capacitors.

Applications:
- Providing power or high-voltage pulses for multiple uses including the following:
  - pulsed klystron radio-frequency amplifiers for particle accelerators
  - neutral-beam modulators for plasma heating and fueling in fusion energy research
  - flu-gas scrubbers on industrial stacks
  - DC conversion for coast-to-coast ties between power grids
  - shipborne energy-conversion systems for radar applications

Multi-Platform Trusted Copy: An Information Assurance File Review and Transfer Tool

Keith Lindsay
Norbert Ensslin
Esther Martinez
Rebecca Michelsen
Sheila Molony
Nabil Schear
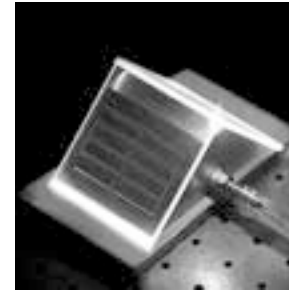*Los Alamos National Laboratory*

Karen Bintz
C&M Enterprises

Multi-Platform Trusted Copy (MPTC) is a cyber security software application used to review computer files for specific elements that can hide sensitive or harmful information. MPTC detects and, in specific cases, removes hidden data. MPTC also searches for user-supplied keywords/phrases and, as part of a comprehensive review, provides a function to open a file in its original application, permitting examination of the keywords/phrases, pictures, and other nontext objects identified in the review. MPTC produces a "cleansed" version of the file and provides for transfer of this "trusted copy" of the file to a removable medium for further distribution. MPTC also generates encrypted logs containing information about who conducted the review and when, what was found, and what information was transferred. Log-file detail could also help identify the person who hid the information.

Applications:
- Document protection—enables the federal government to review documents for hidden, classified, or sensitive data before public release
- Prevention of the transfer of hidden proprietary, personal, or security-related information

CO_2 Laser Welding of Quartz

McIlwaine Archer
Robert W. Carpenter
Martin S. Piltch

Quartz, in its glass form, is an extremely transparent, heat-tolerant, and stable material widely used in industrial and consumer products. Welding is one method of forming quartz into finished products. As traditionally done with hydrogen/oxygen torches, welding is a cumbersome operation that, even when performed by a highly skilled glass blower, yields an irregular, potentially contaminated product. Our new laser welding method produces cleaner, more precise welds quickly and simply. Our method uses a computer-controlled, continuous-wave CO_2 laser, a motion table, and a vacuum-pump system to position, hold, and fuse pieces of quartz glass. A standard shop vacuum removes any contaminants before they can adhere to the quartz surface. Based on the thickness, size, and shape of the quartz pieces and the wavelength and power range of the laser, a technician programs the computer with the appropriate motion-table feed rate and laser settings. The weld is then automatically made and can be repeated as needed.
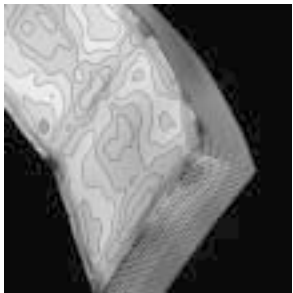
Applications:
- Laser welding of quartz parts used to manufacture everything from headlamps to fiber optics—parts fabricated from quartz can be joined precisely without introducing contamination

Users include high-tech industries such as the semiconductor, medical apparatus, environmental testing, laser technology, and aerospace industries.

CONTOUR: A New Residual-Stress Mapping Technique

Michael B. Prime

CONTOUR is a new technique for making high-resolution maps of residual stress at cross sections within a structural part. It is a simple, cost-effective way to predict, and therefore minimize, the residual stress produced in such parts when they are forged, treated, or welded. The technique is less expensive and more versatile than neutron-diffraction methods. It is also far easier to use and has higher resolution and greater accuracy than conventional sectioning. Because it draws on widely available software and tools (wire electric discharge and coordinate measuring machines), CONTOUR could revolutionize the way manufacturers and materials testing labs measure residual stress.

Applications:
- Mapping internal residual stresses in structural parts of aircraft, destroyers, steam boilers, rail systems, bridges, automobile transmission gears, jet-engine turbine blades, nuclear-reactor control rods, neutron reflectors, and welds of any type
- Prediction and prevention of stress-related failures

IMAGENE—Ultrasensitive DNA Analyzer
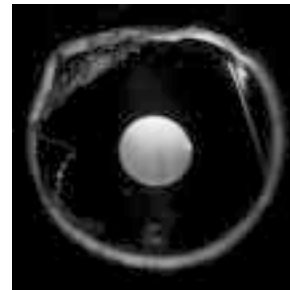
José Olivares
Peter C. Stark
Jeff Wheat
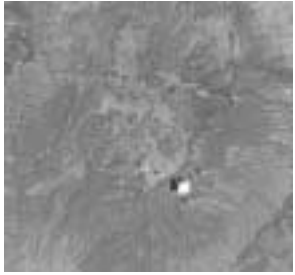*Paul Jackson*

IMAGENE is an ultrasensitive DNA analyzer that images electrophoretic separation of DNA as it occurs. It thereby generates images of the entire ensemble of separating DNA molecules at any point during "separation time," rather than a sequence of piecemeal detection signals at a time subsequent to the separation process. IMAGENE's unique waveguide imaging system markedly improves both the speed and accuracy of DNA analysis. It also permits direct analysis of DNA mutations, an extremely labor-intensive process with existing technologies. IMAGENE's simplicity, speed, accuracy, and versatility underlie its range of application to human genome analysis, genetic-predisposition diagnosis, expeditious pathogen screening for bioterrorist and public-health scenarios, and assessment of forensic evidence.

Applications:
- Final-stage sequencing for the Human Genome Project
- Expeditious identification of potentially pandemic microorganisms
- Accurate discrimination of antibiotic resistance in pathogenic bacteria
- Routine diagnosis of predisposition to chronic illness
- Forensic evidence analysis that preserves original evidence
- Protein analysis for basic research and biomedical screening

GENIE: Evolving Feature-Extraction Algorithms for Image Analysis

Steven P. Brumby
Jeffrey J. Bloch
Nancy A. David
Diana Esch-Mosher
Mark Galassi
Neal R. Harvey
Simon Perkins
Reid B. Porter
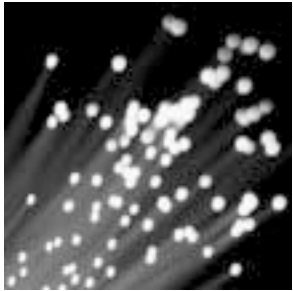*John J. Szymanski*
James Theiler
A. Cody Young

GENIE (GENetic Imagery Exploitation) mimics evolution in order to create more effective algorithms for detecting features in digital images produced by a variety of remote-sensing techniques. GENIE assembles an initial set of low-level, image-processing algorithms (e.g., edge detectors, texture measures, and spectral operators) and then tests each algorithm's ability to find the feature of interest. The "less fit" algorithms are discarded; the "more fit" ones are combined to produce superior ones. After several generations of survival of the fittest, the resulting algorithm is highly optimized. Although features and imagery constantly change, GENIE's ability to evolve superior algorithms allows it to find the features of interest in nearly any set of images.

Applications:
- Mapping damage caused by natural disasters such as wildfires, hurricanes, floods, earthquakes, and volcanoes; or man-made such as terrorist attacks
- Monitoring environmental changes or crop health
- Tracking population growth
- Detecting signs of disease in medical images, product defects in assembly lines, weapons and explosives at airport security checkpoints, and suspect vehicles in traffic

Diana TV—Single-Channel Digital HDTV and Analog Transmissions

George H. Nickel
Frederick J. Wysocki
Scott D. Briles
Erik Stauffer

Diana (**di**gital & **ana**log) TV is a method of transmitting TV signals compatible with both digital high-definition television (HDTV) sets and standard analog TV sets in the same channel. It is meant for use during the national transition to digital HDTV. We accomplish this by placing much of the high-resolution digital image data in the letterbox lines that will be imposed on the analog picture by the wide-screen format of HDTV.

Applications:
- Broadcasting fully digital HDTV signals compatible with analog TV sets for entertainment, news, education, teleconferencing, and public service
- Broadcasting closed-circuit TV systems that must provide both analog TV and digital HDTV signals (in-house, corporate presentation networks, etc.)
- Preventing total HDTV image loss in fringe areas

Disorder Management of Optical Fibers for High-Bit-Rate Data Transmission

Michael Chertkov
Ildar Gabitov
Jamison Moeser
Mac Hyman

Disorder management removes a major barrier to high-bit-rate data transmission over distances of a few hundred kilometers or more through high-speed, fiber-optic communications systems. By reducing the data-transmission errors caused by random variations in the optical fibers' light-transmission properties, we can achieve reliable long-distance data transmission at 160 gigabits per second per fiber channel—more than 10 times the rates of existing long-distance fiber-optic systems. We reduce data errors through disorder management developed with theoretical methods normally applied in statistical physics. Disorder management ensures that future high-speed fiber-optic communications systems will meet the exponentially growing world demand for data-transmission capacity.

Applications:
- Data transmission at high rates across the Internet
- Supercomputer networking

Users include national and international stock exchanges and banks, airlines, insurance companies, health services, publishing houses, news agencies, research institutions, and telecommunications companies.

5-kW High-Value Standby Power Fuel Cell System

Johan Friedericy
Herb Hannam
Greg Jackson
Mark Daugherty
DCH Technology, Inc.

Ben Banerjee
Electric Power
Research Institute

Mahlon S. Wilson
Christine Zawodzinsky
Los Alamos National
Laboratory

David Cepla
UOP, LLC

Eric Plantive
Electricité de France

The 5-kW proton-exchange-membrane (PEM) standby power system is fueled by hydrogen extracted from natural gas through an integrated reformer to provide high-quality electric power instantaneously upon grid drop. This system offers the reliability and quick response times demanded of high-value, standby, power systems as well as advantages in fuel efficiency and air and noise emission reduction that fossil fuel generators and/or lead-acid batteries cannot. Operation is inaudible, there are no hazardous emissions, and the fuel-to-electricity efficiency is twice that of fossil-fuel generators. The global explosion of the digital economy has created such demand for high-quality electric power that the worldwide electric power grid will be unable to meet future demand. We hope to augment the grid with a new generation of standby power systems that can instantaneously take over to provide continuous high-quality electricity when the grid cannot.

Application:
- Providing fuel-cell standby power systems for electric utilities' substations

High-demand users are expected to include the following:
    – data and telecommunication centers
    – wireless communication services
    – cable TV networks